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MI TANK PROGRAM
MATERIAL SPECIFICATION FOR INSULATION SLEEVING, BOOTS AND TRANSITIONS, ELECTRICAL, HEAT SHRINKABLE (LOW TEMP)

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GENERAL DYNAMICS
LAND SYSTEM DIVISION

MATERIAL SPECIFICATION FOR INSULATION SLEEVING, BOOTS AND TRANSITIONS, ELECTRICAL, HEAT SHRINKABLE (LOW TEMP)

SCOPE

1.1 Scope. This specification establishes the requirements for highly flexible electrical insulation sleeving, boots and transitions whose dimensions will reduce to a predetermined size upon application of heat in excess of 275 degrees Fahrenheit (OF).

2. APPLICABLE DOCUMENTS

2.1 Government documents. Unless otherwise specified by revision letter or 0 for initial release, the following documents of the issue in effect on the date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein. In the event of conflict between documents referenced herein and this specification, this specification shall be considered a superseding document.

SPECIFICATIONS

Federal

O-S-1926	Sodium Chloride, Technical
P-C-437	Cleaning Compound, High Pressure (Steam) Cleaner
W-F-800	Fuel Oil, Diesel
W-L-800	Lubricating Oil, General Purpose, Preservative (Water Displacing, Low Temperature)

Military

MIL-A-8243	Anti-icing and Deicing - Defrosting Fluid
MIL-C-372	Cleaning Compound, Solvent for Bore of Small Arms and Automatic Aircraft Weapons
MIL-F-16884	Fuel Oil, Diesel, Marine
MIL-G-3056	Gasoline, Automotive, Combat
MIL-H-46170	Hydraulic Fluid, Rust Inhibited, Fire Resistant, Synthetic Hydrocarbon Base
MIL-I-23053	Insulating Sleeving, Electrical, Heat Shrinkable, General Specification For
MIL-L-2 104	Lubricating Oil, Internal Combustion Engine, Heavy Duty
MIL-L-3 150	Lubricating Oil, Preservative, Medium
MIL-L-7808	Lubricating Oil, Aircraft Turbine Engine,Synthetic Base

MIL-L-23699	Lubricating Oil, Aircraft Turbine Engine, Syn- thetic Base
MIL-L-46 167	Lubricating Oil, Internal Combustion Engine, Arctic
MIL-P-14232	Parts, Equipment and Tools for Army Material, Packaging and Packing Of
MIL-R-46846	Rubber, Synthetic, Heat Shrinkable
MIL-T-5624	Turbine Fuel, Aviation, Grades JP-4 and JP-5

Ordnance

10873919	Electrolyte
12273147	Boot, Adapter, Heat Shrinkable
12273148	Transition, Heat Shrinkable, 3-Entry
12273162	Transition, Heat Shrinkable, 3-Entry, Right Angle
12273163	Transition, Heat Shrinkable, 4-Entry
12273164	Boot, Adapter, Heat Shrinkable
12273176	Boot, Heat Shrinkable, Strain Relief, Right Angle
12273242	Boot, Heat Shrinkable, Strain Relief, Convoluted
12287273	Tape, Adhesive

STANDARDS

Military

MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-45662	Calibration Systems Requirements

(Copies of specification, standards, drawings and publications required by supplier in conjunction with specified procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Non-Government documents. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated the issue in effect on date of invitation for bids or request for proposal shall apply.

American Society for Testing and Materials (ASTM)

	Standard Methods of Test for Dielectric Breakdown Voltage and Dielectric Strength of Electrical Insulating Materials at Commercial Power Frequencies
	Standard Methods of Test for D-C Resistance or Conductance of Insulating Materials
D412	Standard Test Methods for Rubber Properties in Tension
D570	Standard Methods of Test for Water Absorption of Plastics
	Stiffness of Plastics by Means of a Cantilever Beam, Test Method for
D792	Specific Gravity and Density of Plastics by Displacement, Standard Methods of Test for
	Nonrigid Vinyl Chloride Polymer Tubing for Electrical Insulation, Standard Method of Testing
D2240	Indentation Hardness of Rubber and Plastics by Means of a Durometer, Standard Method of Test for
D2671	Heat Shrinkable Tubing, Standard Methods of Testing
D4804	Standard Test Methods for Determining the Flammability Characteristics of Nonrigid Solid Plastics
	Recommended Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

(Copies of ASTM publications may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

3. REQUIREMENTS

3.1 General material reauirements. The sleeving, boots, and transitions specified herein shall have a continuous operating temperature range of minus 70 degrees Fahrenheit (° F) to plus 250 F. The sleeving shall meet the requirements of MIL-I-23053/1A, class 2 for crosslinked modified polychloroprene tubing except as specified herein; the boots and transitions shall meet the requirements specified herein.

3.1.1 Dimensions.

3.1.1.1 Sleeving. Sleeving part numbers shall conform to the dimensions and tolerances shown in Table I. The inside diameter and wall thickness of the sleeving, after heat shrinking by application of heat in excess of 275°F, shall be in accordance with Table I.

TABLE I. PART NUMBERS AND DIMENSIONS 1/

Part Number	As Supplied I.D. Min.	After Unrestricted Shrinkage I.D. Max.	After Unrestricted Shrinkage Wall Thickness 2/
SC-X15112-001	.125	.061	.027 ± .010
SC-X15112-002	.250	.143	.035 ± .010
SC-X151 12-003	.375	.211	.040 ± .010
SC-X151 12-004	.500	.286	.048 ± .015
SC-X151 12-005	.625	.357	.052 ± .015
SC-X151 12-006	.750	.428	.057 ± .015
SC-X151 12-007	.875	.500	.065 ± .020
SC-Xl51 12-008	1.000	.570	.070 ± .020
SC-X151 12-009	1.250	.715	.087 ± .020
SC-X15112-010	1.500	.857	.095 ± .020
SC-Xl51 12-011	1.750	1.000	.107 ± .020
SC-X15112-012	2.000	1.140	.110 ± .020
SC-X151 12-013	3.000	1.710	.125 ± .020
SC-X151 12-014	4.000	2.280	.140 ± .020

NOTES: 1/ Dimensions in inches.
2/ Wall thickness values are less when shrinkage is restricted.

3.1.1.2 Boots. The inside diameters of boots, as supplied, shall be in accordance with drawings 12273147, 12273164, 12273176, and 12273242. Boot inside diameters, wall thicknesses, and other specified dimensions, after heat shrinking (unrestricted recovery) by application of heat in excess of 275°F, shall be in accordance with drawings 12273147, 12273164, 12273176, and 12273242.

3.1.1.3 Transitions. The inside diameters of transition legs, as supplied, shall be in accordance with drawings 12273148, 12273162, and 12273163. Transition leg inside diameters, wall thicknesses, and lengths, after heat shrinking (unrestricted recovery) by application of heat in excess of 275°F, shall be in accordance with drawings 12273148, 12273162, and 12273163.

3.1.2 Physical. mechanical. and electrical properties. The sleeving, boots and transitions shall exhibit the properties specified in Table II.

TABLE II. PHYSICAL, MECHANICAL, AND ELECTRICAL PROPERTIES

Property	Requirements	Test Procedures and Conditions	
		Sleeving	Boots/Transitions 0.075" thick slab
Tensile Strength	1500 psi. min. without rupturing	ASTM D2671	ASTM D412 molded slab
Ultimate Elongation	300% min.	ASTM D2671	ASTM 0412 molded slab
Specific Gravity	1.5 max.	ASTM D792	ASTM D792
Hardness	85±10 Shore A	ASTM D2240	ASTM D2240
Low Temperature Flexibility	No cracking	ASTM D2671 Proc C exposure at -60±5°F 3/8" diameter mandrel	ASTM D2671 Proc C exposure at -60±5°F 1/4" wide molded slab 3/8" diameter mandrel
Stiffness	6000 psi. max.	ASTM D747 1/2" wide strip	ASTM D747 1/2" wide molded strip
Heat Resistance: Tensile Strength Ultimate Elongation	1000 psi. min. 2000 min.	ASTM D2671 at 73±18°F after 168 hr. exposure at 213±5°F	ASTM D412 molded slab at 73±18°F after 168 hr exposure at 213±5°F
Longitudinal Change	10 to 5%	MIL-I-23053	Not Required
Fungus Resistance	Rating of 1 or less	ASTM G21 .	ASTM G21
Water Absorption	2% max.	ASTM D570	ASTM D570
Fluid Resistance	See Table III	MIL-I-23053C at 73±18°F after 24 hr. exposure	ASTM D570, D412 molded slab at 73±18°F after 24 hr. exposure
Tensile Stresr at 200% Elongation	1500 psi. max.	Per MIL-I-23053C	ASTM D412
Dielectric Strength	300 volts/mil min.		ASTM D149
Volume Resistivity	1E11 Ohm-Cm min.		ASTM D257
Flammability	Self extinguishing 15 secs.		ASTM D4804 Method B*
Adhesive Compatibility	Must be compatible with Adhesive Systems per drawing 12347278		

*Time of burning not to include glowing combustion.

TABLE III. FLUID RESISTANCE

Primary Fluid	Temp (±5°F)	Tensile Strength (PSI, Min)	Elongation (%)	Weight Increase (%, Max)	Remarks
Gasoline MIL-G-3056	77	1000	250	25	Note 1
DF-A W-F-800	77	1000	250	15	Note 2
Lube Oil W-L-800	122	1000	250	25	Note 3
Synth. Lube MIL-L-23699	122	1000	250	25	Note 4
Arctic Lube MIL-L-46 167	122	1000	250	5	
Synth. Hyd. Fluid MIL-H-46 170	160	1000	250	10	
Bore Cleaner MIL-C-372	122	1000	250	25	
Electrolyte P/N 10873919	122	1000	250	5	Note 5
5% Salt Sol. 0-S-1926	122	1000	250	5	
Cleaning Fluid P-C-437	122	1000	250	5	
Deicing Fluid MIL-A-8243	122	1000	250	5	

NOTES: 1. Gasoline/gasoline type fuel. Other fuels in category: JP-4 and JP-8, MIL-T-5624.

2. Diesel/kerosene fuel. Other fuels in category: DF-1 and DF-2 per Fed-STD-W-F-800; JP-5 per MIL-T-5624; marine fuel per MIL-F-16884.

3. Petroleum base lubricating oil. Other fluids in category: MIL-L-2104, MIL-L-3150.

4. Synthetic based lubricating oil. Another fluid in this category is MIL-L-7808.

5. Miscellaneous or non-duplicated fluids.

3.2 Special tests and examinations.

3.2.1 Preproduction. When required by the procuring activity (see 6.2) samples shall be inspected prior to production for conformance to the preproduction requirements specified in Section 4.

3.2.2 Initial production. Samples shall be subjected to the initial production inspections and tests for conformance to the initial production requirements specified in Section 4.

4. QUALITY ASSURANCE PROVISIONS

4.1 General.

4.1.1 Resoonsibilitv for inspection. Unless otherwise specified in the contract or order, the supplier is responsible for the performance of all the Quality Assurance Provisions specified herein (Section 4) to determine conformance with the requirements of Section 3 and 5. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the procuring activity. The procuring activity reserves the right to perform or witness any of the inspections set forth in this document where such inspections are deemed necessary to assure supplies and service conform to prescribed requirements.

4.1.1.1 Inspection eauioment. Unless otherwise specified in the contract, the supplier is responsible for the provision and maintenance of all inspection and test equipment necessary to assure that supplies and services conform to contract requirements. Commercial, modified commercial, or supplier designed inspection equipment or measuring set-ups must be capable of repetitive measurements to an accuracy of 10 percent of the component tolerance. Calibration of inspection and test equipment shall be in accordance with MIL-STD-45662.

4.1.2 Special tests and examinations. Special tests and examinations (see 6.3) when required, shall be performed in accordance with Table IV.

NOTE: Assemblies subjected to special tests and examinations shall not be used for any other purposes and shall be indelibly marked, DO NOT USE.

4.1.2.1 Preproduction. If required by the procuring activity (see 6.2) two assemblies shall be inspected by the supplier at a location approved by the procuring activity.

4.1.2.1.1 Preoroduction failure. Failure of a preproduction assembly to meet the requirements specified herein shall be cause for cessation of inspection. When corrective measures satisfactory to the procuring activity have been taken, inspection may be continued.

4.1.2.2 Initial production. Unless otherwise specified, the procuring activity shall select two assemblies from the first ten assemblies produced under a production contract (see 6.2). Once verification and validation of compliance with the requirements has been accomplished, quality conformance inspection of the remainder of the production contract shall be as specified (see 4.2).

4.1.2.2.1 Initial production failure. Failure of an initial production assembly during or as a result of initial production inspection shall be cause for rejection of the assembly. The procuring activity shall refuse acceptance of production assemblies until evidence of corrective action is provided.

TABLE IV. CATEGORY OF INSPECTION

Description	Requirement	Met hod	Special test & examinations		Quality conformance inspection		
					Class of characteristics		
			Pre-prod	initial prod	Critical	Major	Minor
General material requirements	3.1	4.2.1	x	x		Notes 1 & 2	
Dimensions	3.1.1	4.2.1.1	x	x		1.0	
Physical, mechanical, and electrical properties	3.1.2	4.2.1.2	x	x		Notes 1,2,&3	
Preparation for delivery	5	4.3		x			4.0

Notes

1. Lot formation and sampling shall be as specified in MIL-I-23053. A certificate of compliance with supporting data and test results shall accompany each lot.
2. Quality conformance for visual and dimensional inspection and for physical properties specified in MIL-I-23053 shall be inspected per MIL- I-23053.
3. For the physical properties of stiffness and hardness of 4.2.1.2, which are not covered in MIL-I-23053, quality conformance shall be accomplished in accordance with the conditions of MIL-I-23053. There shall be three determinations per sample, and nonconformance of one determination shall constitute failure of the sample.

4.1.3 Quality conformance conditions & controls. Quality conformance inspections shall consist of the inspections and tests specified in Table IV as indicated by the existence of an Acceptable Quality Level (AQL) or frequency of inspection number in one of the classification of characteristics columns. Examples of the number to be used are: 100%, 1.5, and 1/400. Quality conformance inspection shall be performed in accordance with the methods specified in 4.2.

NOTE:

1. 100% means each unit produced shall be inspected for the indicated characteristics (see 4.1.3.1.2).

2. 1.5 signifies an AQL number and indicates the characteristic may be sample inspected (see 4.1.3.1.1).

3. 1/400 signifies a control inspection (see 4.1.3.2).

4.1.3.1 Lot-bv-lot inspection. Lot-by-lot inspection shall consist of sampling and acceptance (100%) inspection as specified in Table IV. An inspection lot shall consist of all assemblies of one type, submitted at one time for Quality Conformance Inspection.

4.1.3.1.1 Sampling. Sampling and inspection shall be conducted in accordance with MIL-STD-105 on the basis of percent defective for those characteristics of Table IV assigned in AQL. Except as specifically designated in Table IV, characteristics having the same AQL shall be treated as a group.

4.1.3.1.1.1 AOL validation. Before sampling can commence for any production contract, a minimum of 20 assemblies shall be subjected to 100% inspection to verify conformance to requirements listed in Table IV. Process average for each requirement shall be computed as specified below. If the computed process average for the requirements exceed the specified AQL, 100% inspection shall be continued until the process average for twenty consecutive assemblies is less than the specified AQL.

$$\text{Process average} = \frac{\text{Number of Defectives}}{\text{Number of Assemblies Inspected}} \times 100$$

4.1.3.1.1.2 Sampling failures. Rejected- assemblies or lots shall be processed in accordance with the acceptance and rejection criteria of MIL- STD-105.

4.1.3.1.2 Acceptance (100%) inspection. For the requirements specified for acceptance (100%) inspection in Table IV, each assembly of the inspection lot shall be subjected to the tests specified therein. Inspection shall be performed by the supplier at the place of manufacture except as specified in 4.1.

4.1.3.1.2.1 Acceptance (100%) inspection failures. Any assembly that fails to conform to any acceptance (100%) inspection shall be rejected. The rejected assembly may be repaired or corrected and resubmitted for inspection

4.1.4 Test methods.

4.1.4.1 Test conditions. Unless otherwise specified, all tests shall be conducted under the following conditions:

Air temperature	73 ± 18°F
Barometric pressure	28.5 (+2.0, -4.5) inches of mercury
Relative humidity	50 ± 30 percent

4.2 Quality conformance inspection.

4.2.1 General material requirements. The sleeving, shall meet the requirements of MIL-I-23053/1A, class 2 except as specified in Section 3 when tested in accordance with MIL-I-23053/1A. The boots and transitions shall meet the requirements as specified in Section 3 when tested in accordance with Table II.

4.2.1.1 Dimensions.

4.2.1.1.1 Sleeving. Sleeving part numbers shall conform to the dimensions and tolerances shown in Table I when inspected in accordance with MIL-I-23053.

4.2.1.1.2 Boots. Boots shall be inspected in accordance with ASTM D876 to verify the dimensional requirements of 3.1.1.2.

4.2.1.1.3 Transitions. Transitions shall be inspected in accordance with ASTM D876 to verify the dimensional requirements of 3.1.1.3.

4.2.1.2 Physical, mechanical, and electrical properties. The sleeving, boots and transitions shall exhibit the properties specified in Table II when tested in accordance with the procedures specified in Table II.

4.3 Preparation for delivery. The assembly shall be visually and dimensionally inspected to verify conformance to Section 5.

5. PREPARATION FOR DELIVERY

5.1 General. Preparation for delivery shall be as defined in Specification MIL-R-46846 and the purchase order (see 6.2).

5.2 Reauirements.

5.2.1 Preservation. packaging. and packing. Unless otherwise specified, the method and materials used in preservation, packaging and packing of the assembly shall be as specified in MIL-P-14232.

6. NOTES

6.1 Intended use. The heat shrinkable sleeving is intended for use as a snug-fitting electrical insulator.

6.2 Ordering data. Procurement documents should specify the following:

a. Title, number, and date of this specification.

b. Applicable levels of preservation, packaging, packing, and marking instructions (see 5.1).

c. If preproduction inspection is required (4.1.2.1).

6.3 Definitions.

6.3.1 Special tests and examinations.

a. Preoroduction. These inspections verify a supplier's capability to produce a component to a specification and/or drawing set. The component may be built on a prototype basis without the use of production tooling. They will be normally conducted whenever a new supplier is selected.

b. Initial production. These inspections verify the production tooling, methods, and processes used to manufacture a component. They are required on selected first articles produced in a production run. These inspections shall be repeated once every 3 years on continuing contracts.

6.3.2 Ouality conformance inspection.

a. Sampling. These inspections verify that physical and configuration characteristics are maintained during the production run.

b. Control. These inspections verify that the integrity of the quality level proven by initial production inspection is maintained during the production run.

c. Acceptance. These inspections are performed on each manufactured item to verify its functional performance against specification requirements.